

## **iSWM Basics Training Summary**

**TO:** Carl Singleton  
Environment and Development Planner  
North Central Texas Council of Governments

**DATE:** November 5<sup>th</sup>, 2024

**FROM:** Randy Peterman, PE, CFM  
Saumya (Sam) Sarkar, PE  
Halff Associates, Inc.

**AVO:** 45347.001

**EMAIL:** ssarkar@halff.com

**SUBJECT:** iSWM Basics Training Summary

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## Introduction

Navigating the development submittal and review process in integrated Stormwater Management (iSWM) communities can present unique challenges for both engineers and reviewers. On October 1<sup>st</sup>, 2024, Baird Hampton & Brown, in conjunction with Halff, presented a workshop discussing best practices, case studies, and lessons learned on the iSWM development submittal and review process. This technical memorandum summarizes the key items discussed during the workshop. These include a basic overview of the iSWM program and its objectives, hydraulic and hydrologic (H&H) methods, common mistakes to avoid in site development engineering, and a summary of the question-and-answer session held at the end of the workshop.

## iSWM Overview

The North Central Texas Council of Governments (NCTCOG) runs the iSWM Program, which provides technical resources on water quality protection, streambank protection, and flood mitigation to North Texas municipalities. The iSWM Program also exists to help cities and counties meet their state stormwater permit requirements. Resources made available to the public as a part of this program include the iSWM Criteria Manual, containing criteria that cities and counties may use as a component of their stormwater management related development regulations, and seven (7) technical manuals that cover various aspects of stormwater management. iSWM online tools are also available to assist with engineering calculations.

Communities that adopt iSWM standards can better manage flooding, protect property values, improve water quality, and meet state and federal regulations. NCTCOG also provides technical assistance to support communities in implementing these stormwater management practices. Many of these stormwater management practices are best implemented during review and approval of development submittals.

Note that each participating community in the iSWM program has adopted iSWM standards to varying degrees. Therefore, upfront communication in pre-development meetings between communities and developers is highly advised. For example, communities and developers should generally agree on what types of studies, permits, and documentation will be necessary to complete a project. Selection of appropriate hydrologic and hydraulic methods for different site conditions and providing necessary documentation are some items that may be discussed at pre-development meetings. The remainder of this memorandum will discuss best practices for navigating these issues in the development submittal and review process.

## Hydrologic Methods

The iSWM Hydrology Technical Manual provides guidance on selecting correct hydrologic methods for specific scenarios. The Rational Method, the Modified Rational Method, and the SCS Unit Hydrograph Method are the most frequently used hydrologic methods within iSWM communities for development submittals. Engineers and reviewers should consider limitations on area prior to using the Rational and Modified Rational Methods as specified in the iSWM technical manuals. This includes accounting for off-site flows – ignoring these flows can lead to significant underestimations of required detention pond sizes, ultimately impacting overall site design. H&H engineers and civil site development engineers should also ensure that their respective drainage area boundary delineations match.

Parameters and methods consistent with the selected hydrologic method should be used to estimate runoff. When using curve numbers, engineers and reviewers should be cognizant of the differences between using base curve numbers and composite curve numbers and avoid “double counting” impervious area. Composite curve numbers combine soil type and land cover to determine a single curve number for a given area. Base curve numbers assume a curve number for undeveloped land and should be used in conjunction with a percent impervious value based on land use. Another common misconception is that the runoff coefficient “C” in the Rational Method directly equates to an impervious cover percentage. Engineers should check if different jurisdictions have different preferred conversion methods.

Commonly used routing methods include Muskingum-Cunge, Modified Puls, and Lag Routing. The Muskingum-Cunge Method is simplistic and best for uniform channels because channel characteristics are estimated based on average dimensions. The Modified Puls Method is best suited for channels with irregular geometry. It requires modeling software, such as HEC-RAS, to define detailed flow characteristics and volume estimates. Lag Routing should only be used for pipe flow.

The October 1<sup>st</sup> workshop also provided general guidelines on calculation of times of concentration. Sheet flow length should be limited to 100 feet for pervious cover and 50 feet for impervious cover. Length of shallow concentrated flow should generally be limited to 3,000-5,000 feet. Longest flow paths for existing and proposed conditions for development projects should be generally different due the addition of pipes, roadways, and bar ditches. Engineers should use lag time in their calculations when using the SCS Unit Hydrograph Method, rather than time of concentration, a common error identified during the review process.

Engineers should avoid over-reliance on older plans that may contain inaccuracies or are no longer representative of site conditions. Verification of data through field visits or survey data are recommended in such instances. Moreover, older plans may show stormwater systems designed to less stringent criteria or contain calculations that use out-of-date rainfall data.

## Downstream Assessments

Downstream assessments are necessary to protect downstream properties from increased flooding due to development. Development typically increases discharge unless mitigated by detention structures, and jurisdictions often require downstream assessments to manage this increased flow. This process includes identifying site outfalls and the Zone of Influence, defined as a downstream point at which the discharge from the proposed site no longer has significant impacts. The generally accepted standard for the Zone of Influence is the 10% rule-of-thumb that identifies the point where the proposed site comprises 10% or less of the contributing watershed. Hydrologic and hydraulic analysis are performed from each site outfall through the Zone of Influence to determine if there is an increase in runoff causing adverse impacts and if mitigation is required. This rule can be impractical in some scenarios, such as with very small developments near comparatively large creeks or rivers. In these cases, engineers should discuss with city staff ahead of time what an appropriate method and sufficient stopping point along a stream would be.

Multi-phase projects present additional challenges. Regardless of the method preferred by the jurisdiction, it is important to evaluate each phase of a multi-phase project individually. For instance, in a three-phase development, each phase must each be assessed for its own impact, not just the overall project.

A common mistake encountered in reviews of downstream assessments is incorrect assumptions regarding tailwater conditions. Lakes or large rivers could have boundary conditions that significantly affect hydraulic models. Speakers in the October 1<sup>st</sup> presentation recalled a project they had reviewed where the modelers had failed to account for tailwater of a receiving body of water, and in doing so they underestimated the tailwater conditions by 15-feet.

Different municipalities that have adopted iSWM often have different criteria for what velocities they consider to be erosive. Generally, proposed conditions should mimic existing conditions to avoid adverse impacts to velocity on downstream systems. Ensuring that new developments do not increase erosive velocities is essential for maintaining the stability and integrity of streams.

## Detention

Detention ponds are commonly used to prevent adverse impacts downstream of a property. Onsite storage design methods include the Modified Rational Method and the SCS Unit Hydrograph Method. The Modified Rational Method is best used for design of small detention facilities, but it typically under predicts the required detention volume compared to other methods. The SCS Unit Hydrograph method is more appropriate for larger drainage areas but requires more complex hydrologic conditions.

Tailwater conditions must be accurately accounted for when modelling detention ponds. City criteria generally include maintaining a foot of freeboard in detention ponds to account for storms exceeding the 100-year event, 4:1 bank slopes depending on soil type, and 10-foot wide access ramps for maintenance crews. Emergency spillways must be designed to handle fully developed conditions upstream to prevent ponds from overtopping. Geotechnical investigations are also essential for ensuring the stability and proper compaction of berms, especially for larger structures.

## Hydraulics

The iSWM Hydraulics Technical Manual provides guidance on choosing correct hydraulics methods for modeling different stormwater conveyance systems. Stormwater conveyance systems may include open channels, culverts, and bridges. Open channels can be existing natural channels analyzed for water conveyance, or engineered channels designed to meet specific needs such as increasing capacity or directing flow. When modeling culverts and bridges, different equations apply when either the inlet or the outlet is submerged or unsubmerged. Both entrance loss and exit loss coefficients in addition to contraction and expansion coefficients must be considered to accurately model culverts.

Erosive velocities are another key factor to consider in hydraulic design. When designing erosion control structures, it is important to apply standards based on the specific site conditions and requirements, rather than a one-size-fits-all approach. Erosion protection structures like baffle blocks, riprap, and gabion walls are designed to protect against erosive velocities, not reduce them. Proper placement and armoring of outfalls is also important – velocities are typically higher coming out of outfalls than what receiving channels are designed to handle. Engineers should avoid placing outfalls perpendicular to receiving channels. Engineers and reviewers should also be mindful of potential for erosion when outfalls are placed in areas without existing channels; it is advisable to avoid creating new channels in inappropriate locations like residential backyards.

Lastly, criteria for modeling and designing inlets, storm drains, and roadside ditches can also vary from community to community. For example, some jurisdictions will allow parking lots to flood up to six inches, while others prioritize emergency access and only will allow spread within a curb and gutter during design storm events. Also, speakers at the October 1<sup>st</sup> presentation have reviewed projects where both inlets in sag and inlets on grade were calculated and evaluated using the same methods; these are two distinct types of inlets with different considerations for design and performance.

## Other Site Development Considerations

The following section will discuss other common pitfalls and best practices for site development projects, such as providing necessary documentation, like easements and maintenance agreements. Communication in pre-development meetings between communities and developers generally prevents many of these issues from occurring later in the development submittal process.

Preliminary plats typically demonstrate the intent of a project, include preliminary grading, drainage, and utility layouts, and are accompanied by a full drainage study. Final engineering plans should provide detailed support for easements and address all on-site and off-site drainage needs. Maintenance agreements for ponds and channels are essential to ensure the upkeep and serviceability of drainage facilities and should clearly define maintenance responsibilities and standards. Enforcement of these agreements varies by city. For example, larger cities with MS-4 permits often have inspection and enforcement mechanisms, while smaller cities may rely on good faith efforts. Pipes, engineered channels, ponds, and other conveyance systems may require drainage easements and must be designed with adequate consideration for maintenance access.

Removing natural and man-made pollutants from stormwater is necessary for effective water quality management. This starts with integrated construction criteria and intentional placement of waste disposal facilities on-site. Integrated construction criteria include erosion and sediment control measures such as silt fences, check dams, and sediment basins. Working with industry partners and technical representatives on how best to manage stormwater runoff can yield innovative and highly effective results. Stormwater best management practice (BMP) manufacturers have ever-evolving product lines, which can include inlet protection devices, trash racks, filters, and more. In general, using multiple smaller BMPs distributed throughout the site rather than relying on a single large system is often a more effective strategy, especially when space constraints are a concern.

## Q&A Session

The following section will summarize the question-and-answer section of the October 1<sup>st</sup> presentation:

- “How often and to what degree do cities enforce maintenance agreements?”
  - It varies significantly among cities. Larger cities have more structured inspection and enforcement mechanisms due to MS4 permitting requirements, while smaller cities may rely more on good faith efforts. Even if there is no maintenance agreement in place, reviewers often will want to at least see that there is a plan to maintain, whether by the Homeowner’s Association or the developer.

- “Are iSWM silt fence installation criteria suggestions, or enforceable rules?”
  - This is a city-by-city issue. Cities can choose to adopt as much of iSWM criteria as they want. ISWM resources are just that – resources. It’s good to keep in mind, however, that cities may have preferences that are not written in manuals.
  
- “What are the trends in adopting permanent BMP requirements?”
  - More cities are starting to require permanent BMPs for stormwater management, even for smaller projects. Cities like Arlington, Celina, and Mansfield have ordinances in place and others are beginning to follow suit.
  
- “What considerations should engineers and developers keep in mind when providing proper easements for stormwater infrastructure?”
  - It is not always clear where exactly an easement should go in relation to a body of water. For example, an easement could be drawn at the toe of a berm, or at the top of a berm. Different cities will have different criteria. Sometimes there are multiple good choices. Engineers should also understand that maintenance requirements vary between drainage and floodplain easements. Earthen drainage easements are often required to be maintained seasonally.
  
- “Are communities in attendance charging for drainage reviews?”
  - Yes, Burleson is, and many other communities not in attendance also do so.
  
- “What can municipalities improve on to make it clear what developers need to submit?”
  - Well-developed, publicly available ordinances and design criteria, along with pre-development conferences and checklists, are crucial to ensure clarity and compliance from the start.